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MONTHLY PROGRESS REPORT NO. 1

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Rocketdyne
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LH₂ AND LO₂ TURBOPUMP ASSEMBLIES PROGRAM

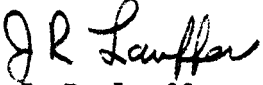
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NAS8-27794


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INTRODUCTION

Hydrogen-Oxygen Auxiliary Propulsion Systems (APS) will be required for the Space Shuttle Vehicle Orbiter and Booster stages. APS subsystem definition studies have indicated that turbopump-fed systems are optimum. The purpose of this program is to design, fabricate, development test, acceptance test, and deliver two (2) each LH_2 and LO_2 turbopump assemblies. Each assembly consists of a pump, turbine, power source, and associated shutoff valves. The overall program schedule is shown in Fig. 1, including the division of program efforts and key milestones.

This monthly report presents a summary of program status including identified problem areas, progress achieved during the report period, the work performed during the report period and the work to be conducted during the next report period.

PROGRAM STATUS

The program effort during the first report period was devoted primarily to Phase I. The effort in Phase I General Screening Analysis has been 75 percent completed for both the LH_2 and LO_2 TPA. This effort has culminated in the identification of alternative TPA concepts and the recommendation by Rocketdyne for adopting a specific configuration will be made 18 August 1971. The results of the study will be presented to NASA on 18 August 1971 followed by formal documentation ten days later. The milestone requiring submittal of the Program Plan by 14 July 1971 was completed on schedule.

During this report period, no problems or unforeseen technical difficulties were identified. The program is on the planned schedule and budget.

LO₂ AND LH₂ TPA PROGRAM

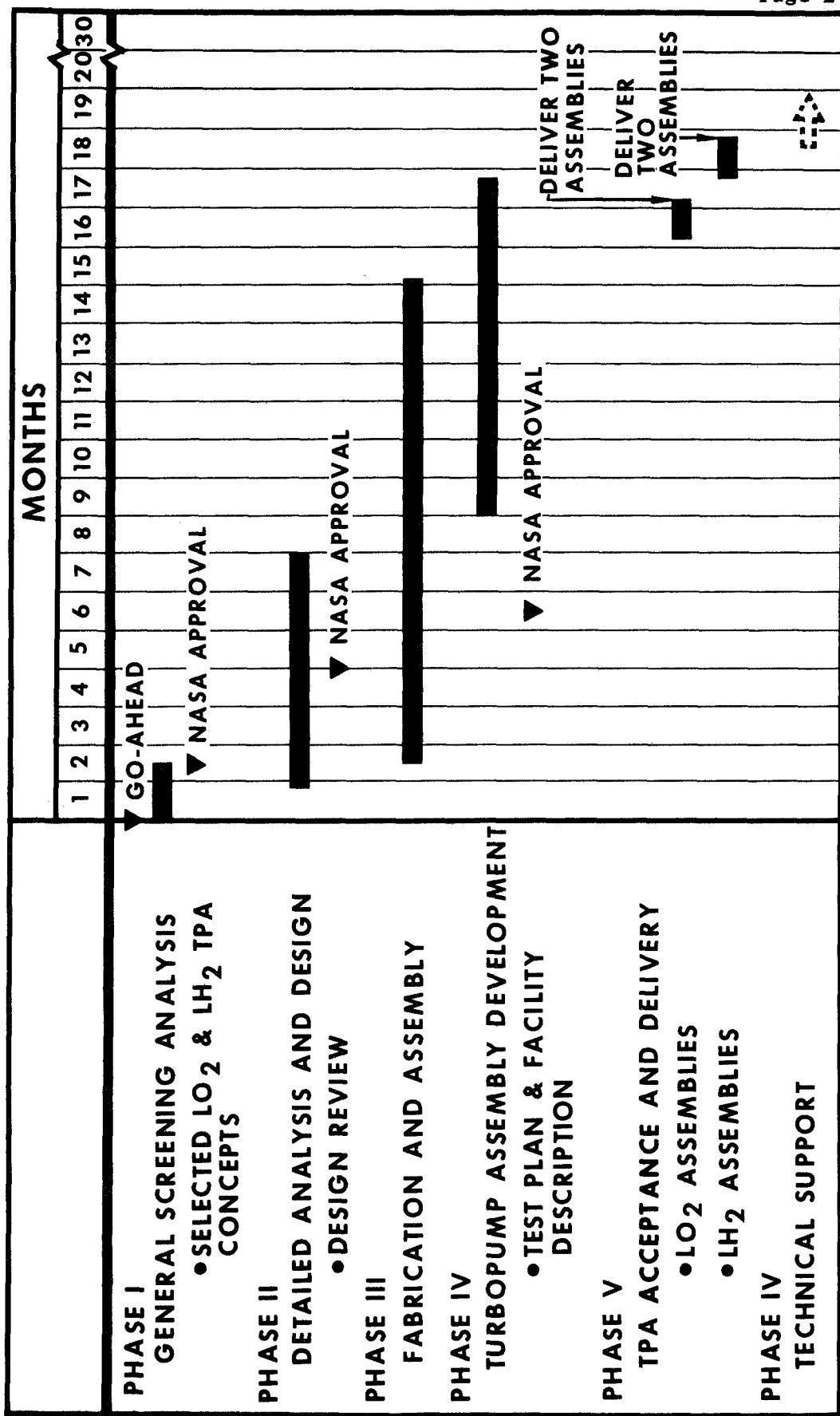


Figure 1

SUMMARY OF PROGRESS

PHASE I

The key progress achieved during this report period consists of definition of the program as presented in the LH_2 and LO_2 Program Plan and the completion of the preparatory effort for selection of baseline LH_2 and LO_2 TPA configurations.

SUMMARY OF WORK PERFORMED

PHASE I

Following contract go-ahead, the General Screening Analysis for selection of a baseline configuration was initiated.

A program kick-off meeting was conducted at the MSFC on 7 July 1971. Rocketdyne presented applicable analyses conducted under previous contracts and company funding utilized in narrowing the selection of alternative configurations. In addition to a general refinement of study requirements, the significant drivers in the selection of TPA components were identified as (a) ability of the system to meet transient operating requirements, (b) minimization of pump thermal conditioning and (c) minimization of nonpropulsive losses.

The Program Plan was prepared in conformance with the format stipulated in the NASA Scope of Work. The Plan presents a detailed breakdown of the six (6) phases of the program in terms of schedule as well as logic flow. The plan was submitted on 14 July 1971 as specified.

As part of the program coordination effort, Rocketdyne was represented at the Breadboard Propellant Acquisition meeting conducted at MSFC on 3 August 1971 to identify possible interaction with the turbopump assemblies. The specific areas of bypass flow, system pressure oscillations and pump thermal conditioning requirements were identified as requiring definition by the contractors to assure satisfactory integration of the system.

Because of the primary role of the turbopump portion of the TPA, major emphasis was placed on its selection during the Phase I General Screening Analysis. The selection of the shaft speed was predicated on meeting the specified NPSP requirements of 0, 1, 2, 3 psia on the LH_2 pump and 2, 4, 6 psia on the LO_2 pump. The speed selection coupled with the pump discharge requirements and the maximization of efficiency established the alternative number of stages. With a fixed pump speed, the turbine alternatives were selected based on efficiency, thermal fatigue life and horsepower requirements. The resulting turbopump configurations were then traded off based on NPSP, transient operation, bearing life, and thermal conditioning requirements. The final selection will include consideration of cost, fabrication, and development program factors.

With suitable techniques for minimizing thermal soakback identified during the proposal effort, studies of the refrigeration, recirculation, and combined pump chilldown coolant flow requirements were established. In addition, the thermal conditioning requirements for dry pump versus wet pump start conditions were evaluated.

As part of the turbopump design analysis, bearing, liftoff seal and dynamic seal concepts were assessed and preferred configurations were established. In addition, methods of contamination prevention in areas of the bearings were also determined.

The gas generator technology applicable to this program both available from previous effort and currently under study was assessed and alternative configurations selected based on utilizing demonstrated concepts to assure reliable operation.

The valves to be utilized in the LH_2 and LO_2 TPA systems were selected based on system requirements, and availability.

The systems analysis effort was primarily directed towards dynamic analysis of the system to establish start time, NPSP, and system head flow characteristics. The specified system requirements in terms of use of a backpressure regulator for controlling pump discharge flow, heat input into the propellant, and inlet line dynamics resulted in dismissing the dead head start as an alternative and established the need for some bypass flow during the start transient. The system start times to nominal flow and discharge pressure did not significantly vary for the alternative configurations.

As part of the system analysis effort a Failure Mode Effects Criticality Analysis was conducted and safety requirements to preclude the identified failure modes were identified. As part of this effort special attention was directed to overspeed detection response and cutoff. Analysis indicated that up to .25 seconds is available for detection and cutoff response. This time is considered more than adequate for magnetic pickup speed detection and valve closure. Passive devices were evaluated and though no specifically applicable device is available, devices of this type were identified as technology areas that could be beneficial.

A preliminary packaging arrangement was prepared to locate components in their respective positions to aid in the determination of structural requirements as part of the Phase II Detail Design effort. The layout is presented in Fig. 2.

FUTURE WORK

During the next report period, the conclusions of the Phase I General Screening Analysis will be presented to NASA and a configuration selected. The Phase II Detail Design of the selected configuration will be initiated with particular attention to identification of long lead items.